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Notes for Libraries and Research Institutes

FORMER ISSUES OF AGRICULTURAL JOURNAL

So many requests are received from abroad for parts of the "Agricultural Journal" which were never published that the following list of all issues published and those which are not now available is given for reference. Attention is especially directed to Volume 7 which had only one part :—

Vol.			Vol.		
1.	3 numbers,	1928.	13.	4 numbers,	1942.
2.	4 ,,	1929.	14.	4 ,,	1943.
3.	3 ,,	1930 (none).	15.	4 ,,	1944.
4.	4 ,,	1931.	16.	4 ,,	1945.
5.	2 ,,	1932 (none of No. 2).	17.	4 ,,	1946 (none of No. 1).
6.	2 ,,	1933.	18.	4 ,,	1947 (none of No. 1).
7.	1 ,,	1934.	19.	4 ,,	1948 (Nos. 3 and 4 form a double issue).
8.	4 ,,	1935-7 (none of No. 4).			
9.	4 ,,	1938 (none of Nos. 2, 3 and 4).	20.	4 ,,	1949.
10.	4 ,,	1939 (none of Nos. 2 and 4).	21.	3 ,,	1950 (none of Nos. 1 and 2 combined).
11.	4 ,,	1940 (none)			
12.	4 ,,	1941 (none of Nos. 1 and 2).	22.	1 ,,	1951.

ISSUES OF AGRICULTURAL CIRCULAR

NUMBERS and year of issue of the "Agricultural Circular" :—

Vol. 1, 1920,	12 numbers.	Vol. 4, 1923,	1 number.
2, 1921,	5 ,,	5, 1924-5,	2 numbers.
3, 1922,	4 ,,		

As number 4 of Vol. 3 was printed as "Volume 4" and number 1 of Vol. 4 as "Volume 5" it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

ANNUAL BULLETINS

THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

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FREE copies of the following Bulletins are available to Colonial Departments of Agriculture research institutes and bona fide planters within the Colony.

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5. Scale Insect on Bananas, 1913.
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7. A Mission to Java for a Coleopterous Pest of Bananas, 1914.
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Applications should be made to the Librarian, Department of Agriculture, Suva, Fiji.

—EDITOR

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EDITORIAL . . .

LIVESTOCK PRODUCTION

The development of highly productive livestock is a matter of considerable concern to tropical agricultural communities. Apart from providing the best source of high quality protein for human nutrition, livestock as an integral part of a farming system aids in the all important problem of maintaining soil structure and fertility.

The matter is of special significance in Fiji. First, there are considerable areas of land which are suitable only for grassland farming. Any other method of utilisation would lead to rapid soil loss. Second, holdings on the better class lands are usually small in area and can only support a few animals. It is essential therefore that such stock should be highly productive. Thirdly, fertilizers are costly and may be beyond the reach of the small peasant farmer. His main hope in maintaining soil fertility is to include stock on his holding and adopt a system of management suitable to the size of the farm. Fourthly, we are not producing sufficient meat and dairy products to meet the needs of our population which is rapidly increasing. The Colony's bill for imported meat and meat products, fish and dairy products is not far short of half a million pounds per annum.

With limited land resources and small holdings we must breed livestock of highly productive strains and for sustained high production develop, and maintain by suitable management, superior grasslands and improved fodder crops, and control disease.

The problems of raising superior livestock under tropical conditions are many and are peculiar to warm humid environments. High yielding superior quality grasses and legumes which have done so much to improve livestock production in temperate countries cannot be established or, if so, cannot compete with the more vigorous rank grass growth and weeds of the tropics. High producing strains of livestock under temperate conditions do not necessarily adapt themselves to a warm environment, and management of stock, feeding methods and grassland management call for a different approach.

On the whole livestock raising under tropical conditions has been tackled in an empirical manner and very little has been done (until within recent years) along the lines of a fundamental approach to basic practical problems of breeding, rearing, feeding and management.

During the past ten years the Department of Agriculture has given close attention to all problems of livestock production and with the development of agricultural stations has, within recent years, taken a leading part in this work in the South Pacific tropical region.

This copy of the *Journal* contains several important papers on livestock production. They were delivered at Sigatoka Agricultural Station during the course of a field day which was attended by farmers and other interested citizens from all parts of the Colony. These papers give a valuable account of studies on acclimatisation, breeding, feeding and management of livestock, the establishment of pastures, the control of internal parasites and diseases of poultry.

It is evident that considerable progress has been made. By concentrating on suitable tropical grasses and legumes following introductions from other territories over a number of years, it seems likely that a suitable grass-legume cover which stands up to grazing can be established on the soils of Sigatoka. More careful work on local grasses and legumes would appear to indicate that by altered grazing management and the production of silage during periods of lush growth, animals can be kept in good condition throughout the year with marked improvement in carrying capacity.

Of considerable importance also is the recognition that there would appear to be a physiological limit to production of European breeds of livestock in a tropical environment despite the plane of nutrition. Heat tolerance however is an important factor in determining the limit of production in superior strains under optimum feeding conditions. It would appear also that heat tolerance is a hereditary factor and in consequence our views on breeding have been altered.

Of immediate practical interest are the findings of the behaviour experiment. Animals in the tropics do most of their grazing during the hours of darkness and the cooler parts of the day. It is during the hours of darkness that pastures should be rotationally grazed and the animals kept under shade during the hot day. The reverse practice leads to poor feeding and poor production. This alteration of management involving heat tolerant high-producing strains on good pasture should help still further to redress the physiological limit to production imposed by a tropical environment.

Despite good pasture and heat tolerant animals production can be severely reduced by internal parasites. This is a matter of considerable importance to the practical farmer and plans have been formulated for the study of this limiting factor to livestock rearing and production.

These papers are well worthy of careful study by all farmers and graziers and they indicate that the approach to problems of livestock production in the tropics is along sound and practical lines.

—W.J.B.

AGRICULTURE . . . .

EXPERIMENTAL METHOD

BY NORMAN LAMONT, M. AGR. SC., OFFICER IN CHARGE, P.A.S., KORONIVIA

From time to time results of experiments are reported in this Journal and as it would be unbearably tedious to explain in full detail the methods employed in each and every case, a brief account of the principles involved may be of interest and may assist readers to interpret more clearly the findings that are reported. The principles of experimental method are quite straightforward—although the mathematics employed are by no means always simple—but there is a tendency to use words and forms of expression that are not current in everyday language, and while these may be more precise and perfectly clear to those familiar with them, they tend to obscure simple issues for those unaccustomed to the terminology employed.

Biometry is the statistical method applied to field experiments and is a fairly recent development in agricultural research which is proving of enormous benefit. Whereas in the past much time and effort were wasted through results being inconclusive or because their reliability could not be properly assessed, it is possible now by using proper statistical designs in the field and by proper statistical analyses of results, to accumulate information, the reliability of which is no longer a matter of personal judgment but which is capable of measurement and expression in exact and impersonal terms.

Every farmer—even every home gardener—knows that, when dealing with the soil and plants, results secured are never precisely the same, no matter how carefully one may attempt to follow the same planting and cultural practices. Nature is infinitely variable, perversely inconsistent and quite hopelessly unpredictable.

Even if we exercise the utmost care in selecting a level and apparently uniform area of ground and plant two equal plots with, for example, seed padi from the same sack we know that there is a very remote chance that exactly the same yield will be secured from each. If we plant three, four or five areas we can only expect three, four or five different yields. These differences are due in part to the human element and in part to unavoidable and unpredictable differences in soil fertility from one part of a field to another, which are present no matter how carefully the ground is chosen.

Consequently if we wish to compare the yields of different varieties of rice it would be quite useless simply to plant one area of each and measure the yield from them, as we would have no way of knowing whether hidden differences in soil fertility had exaggerated, obscured or even reversed the real difference in productivity between our varieties.

By using a properly planned layout of plots it is, however, possible to a large extent to actually measure the disturbance due to soil fertility difference over the field and to extract this from the differences in yield that are genuinely attributable to differences between our varieties. This is done by grouping the varieties under trial into blocks of plots, each block containing one plot of each variety. We then plant a number of these blocks, usually four, six, or even eight. For instance, if we wish to compare the yields of Ramcajara, B.G. 79, B.G. 75 and New Guinea rice, we would have probably six blocks of the four varieties, all arranged compactly in an even piece of ground.

Any differences in total yield of these blocks, which each contain all varieties, must therefore be due to differences in soil fertility or to other uncontrollable factors. These differences can be measured, expressed in mathematical terms and excluded from our measurement of the yields of the five different varieties under trial. This means, of course, that we are able to measure accurately much smaller degrees of difference between varieties than would be possible if the figures were obscured by the effects of soil fertility variations. We have too six plots of Ramcajara, six of B.G. 75 and so on because each of our six blocks contains one plot of each of the varieties. Our yield figures for the varieties are there-

fore based on the average of six plot yields in each case.

Say, for example, that we find that the six B.G. 75 plots average 22 cwt. per acre and the six Ramcajara average 20 cwt. per acre. How can we be sure that this difference of 2 cwt. is really genuine and not due to some chance influence of which we were unaware? One might say that, since our figures are averages of six plots and since we have already done our best to eliminate soil fertility effects, the results should be safe. This is true, but it is possible to actually measure the reliability or "significance" of this 2 cwt. margin. Consider the following exaggerated case—say for instance the B.G. 75 plots had yielded as follows—

13; 28; 15; 25; 22; 29; average 22.

and the Ramcajara plots as follows—

12; 25; 14; 20; 27; 22; average 20.

It is quite obvious that the individual plot weights are extremely variable indeed and consequently the difference between the averages could not be considered anything like so reliable as it would be if the individual plot yields have been something like this—

B.G. 75: 20; 22; 24; 21; 23; 22; average 22.

Ramcajara: 20; 18; 21; 22; 20; 19; average 20.

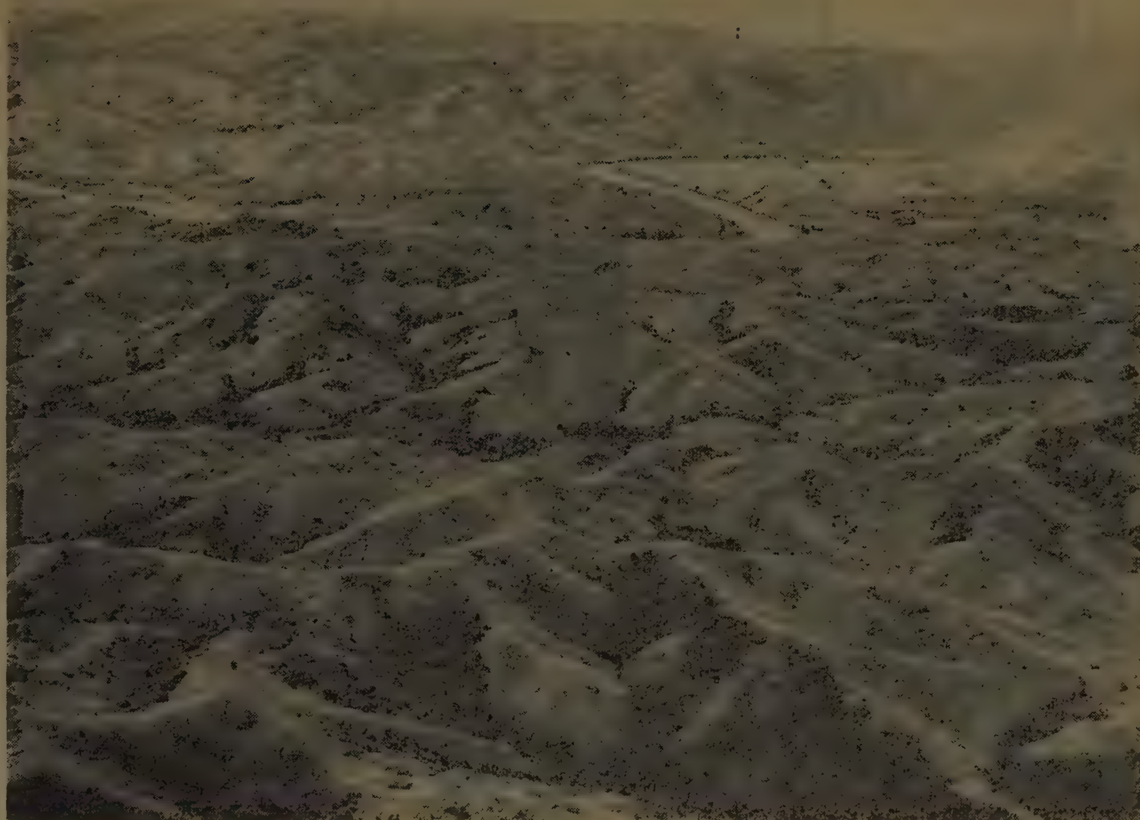
These examples are exaggerated to illustrate the point and it is I think clear that the reliability or "significance" of the difference between the averages of the varieties depends upon the evenness of the individual plot yields that make up these averages. By applying mathematical formulæ a precise measure of the "significance" of differences can be calculated and reliance or doubt placed upon the results in consequence.

This is by no means the whole story of our work in selecting and improving rice varieties in the Colony. We still have to lay down trials sown or planted at different times during the season to determine how far time of planting may affect the behaviour of varieties and we have to repeat our trials over a number of seasons to determine the effect of overall seasonal conditions. The above merely attempts to explain the procedure employed for each individual rice variety trial that is laid down at Koronivia. For instance three main trials last year consisted of one eight variety with six replications, totalling 48 plots; one 8 by 8 or 64 plots and one 6 by 6 totalling 36 plots.

It is clear that the work is very exacting and very demanding of time and staff—at least in the short-term view point. On the other hand, the findings of a properly designed and completely analysed experiment provide information in which one can place the fullest confidence and in a form which can be interpreted by others in quite impersonal terms. It is a step forward which need never be retraced and which is a permanent contribution to our knowledge on the subject.

Finally the exploitation of statistical techniques makes it possible to distinguish with certainty quite small differences in varietal production. For instance, we have at the moment at least six varieties of rice that are good productive types and it is only by very careful work over a number of years that we can hope finally to ascertain which is most consistently the best. Since the Colony's annual rice crop is worth about £1,000,000, an improvement of only a very few per cent is a very important one to the Colony as a whole—even 1 per cent improvement is vastly more than the total cost of our rice improvement work.

To summarize, therefore, I think it is clear that the use of these apparently complicated methods involving a great deal of cautious repetition of trials and plots within each trial is not due to any fondness on the part of research workers for the mental gymnastics involved. It is made necessary first of all by the variable and uncontrollable nature of the materials with which field experiments are concerned, with the need for securing results whose dependability can be accurately assessed and impersonally recorded for those who may continue the work—and finally, as the work develops, through the need to be able reliably to separate varieties or practices between which differences which appear small, may nevertheless assume considerable importance to the Colony as a whole.



A view of the Sigatoka Valley showing the extent of the rough hill grazings. The Agricultural Station can be seen in the centre background along the banks of the Sigatoka river.

Animal husbandry . . .

ANIMAL PRODUCTION IN FIJI

The theme of the second annual Field Day held at the Sigatoka Agricultural Station on Thursday, October 4th 1951 was, " Animal Production in Fiji ". Five papers, all concerned with this theme were presented at this meeting, and it has been thought desirable to present these together in this journal so that the information is available to a wider public.

INTRODUCTION

BY C. HARVEY, C.B.E.

When the opportunity occurred in 1946 of re-organising the Department following the visits of Professors Shephard, Paterson, and Dodds, two important directives were written in to the " Statement of Policy and Action" which was accepted by Legislative Council as a programme for the Department. One was that the Department Stations should be adequately staffed and equipped to undertake an investigational programme that had a direct bearing on the practical problems of the industry, and the other that an Advisory Council on Agriculture, representative of all sections of the industry, should be established in order to ensure the closest co-operation between the work of the Department and the needs of the Colony's farmers.

We have endeavoured faithfully to carry out these directives. The Advisory Council on Agriculture has been in existence for several years and members have taken a keen and critical interest in the work of the Department. As far as the work of the Stations is concerned you will all realise that it takes time to develop a station, to provide the necessary facilities and to organise a programme of investigational work. The station at Koronivia had to start from scratch but, as some of you were able to see last week, good progress has been made. This station (Sigatoka) had already been in existence for many years, but only during the last three years has it been adequately staffed and equipped to undertake investigational work on a reasonable scale, and we hope that considerable further development will be possible.

This station is primarily concerned with livestock and the central theme of all the lectures and demonstration during the next three days is " Animal Production in Fiji ".

You are aware of the importance of livestock products in human nutrition and there is a great demand for them in the Colony. There is a shortage of milk in most of the large centres of population and a serious shortage of meat. In 1950 the Colony imported from overseas four times as much meat as in 1938, and it cost nine times as much, so that you can see the importance of adequate local meat supplies. Livestock are also important to the farming economy: mixed farming or the combination of livestock with crops is accepted the world over as the soundest basis for any permanent or stable system of agriculture.

On this station you will see that much of the work is directed towards the demonstration of the value of rotating field crops with temporary grass grown for livestock production.

There is also, of course, the problem in this Colony of making use of the very extensive hill lands, which amount to almost one third of the total land area of the Colony and are quite unsuitable for planting crops. How to get the most out of this land, and how to replace the guava and other weeds with pasture grasses and legumes, raise problems to which we have as yet no certain answers, but we hope and believe that this Station will make important contributions in the solving of these problems in the future.

AGRICULTURAL STATION, SIGATOKA

A REVIEW OF ACTIVITIES

BY W. J. A. PAYNE

We have chosen as our theme for this meeting "Animal Production in Fiji" and I wish to spend a short time explaining how and where our station activities fit into this theme.

The station covers an area exceeding four hundred acres but only one-fifth of it is ploughable land, the remainder being irregular areas or rough grazings. The normal rainfall is seventy to eighty inches per annum, one-quarter falling between June and November, and three-quarters between December and May. The range of air temperature is from 50°—100°F., the annual mean temperature being 75.7°F. The ploughable area consists of silt soils quite similar to much of the Colony's best arable land, while the rough grazings are somewhat typical of a large part of the rough grazings that cover one third of the Colony. An alternate husbandry system of farming is being developed on the ploughable area, one half of it being under temporary grass and one half under arable crops. A dairy herd is run on this area, while the rough hill grazings are being fenced and a start has been made to utilise them for goat and beef cattle production.

Animal production can only be studied successfully if we assess the importance of climate, breeding, nutrition and management simultaneously. Each of these factors reacts on the others and to-day we hope to review the work that is is progress in each of these fields.

A study of the effect of the climatic environment on our livestock is fundamental. We cannot at present alter our climate, though we can ameliorate its worst excesses. Until we decide on the type of animals that we require our breeding programme must be in some ways unsatisfactory. Once we are satisfied that we know what to breed for we have to ensure that we can feed the animals properly. Pasture grass is undoubtedly the cheapest and most satisfactory feed for dairy and beef cattle, horses, goats and sheep, but we not only have to find out the most suitable pasture species, but we also have to learn how to manage them, and how to "iron out" the very large seasonal differences in productivity. Finally we must learn how to manage our stock so that the excesses of climate are ameliorated, the dangers of parasites and disease are minimised and feed and labour are utilised as economically as possible.

It is a formidable programme, and of course we can only deal with certain sections of it at this station. We have concentrated our attention on studying the effect of a tropical climate on European type dairy stock, and on learning how to manage and utilise economically our present pasture species. We have also studied the behaviour of dairy stock and have concluded that management must be radically different in the tropics from that in the temperate zone. We are recording all our herds and collecting and tabulating a large number of facts that may be of use to us in formulating breeding programmes. We are also investigating mundane but essential problems such as the most suitable and economical type of fence, the design of farm buildings, etc.

ACCLIMATISATION STUDIES

BY W. J. A. PAYNE

In most humid tropical countries animal production is very inefficient. This is partly due to the fact that it is inherently more difficult than in the temperate zone, and partly because little research in animal production has been conducted in the tropics.

All animals produce heat, but warm-blooded animals such as domestic livestock produce it more rapidly than others and the faster the animal grows or the more milk it gives the more heat is produced. This does not usually create difficulties for the animal

in a temperate zone as the heat that is generated is used to keep itself warm, but it can easily be seen that as the air temperature rises the problem of heat loss becomes more acute. The animal must keep a balance between heat production and heat loss, and in fact it possesses a type of thermostat which is situated at the base of the fore-brain. If heat production rises too rapidly and the body temperature gets out of hand the whole system breaks down and the animal dies. It is usually considered that the critical temperatures are 106—107°F. for animals and 112°F. for domestic birds.

The animal is equipped with a number of mechanisms for adjusting heat loss and these vary in their significance from animal to animal. Heat is lost from two surfaces, the outer skin, and the epithelium of the respiratory system, by either (*a*) radiation, conduction, or convection, or (*b*) vapourisation of water. It is also lost by the excretion of fæces and urine. Some of the factors affecting heat loss are the ratio of body surface to body volume, the number of functioning sweat glands, the respiration rate, the water intake and urine output, the rate of flow of blood to the skin capillaries, the degree of dilation of the skin capillaries, the thickness of the skin, the length, density, and detailed arrangement of the body hair, and of course the external climatic conditions.

Man has a particularaly efficient sweating mechanism, but most other animals rely on other mechanisms to rid themselves of surplus heat. Cattle, goats, and sheep easily increase heat loss by increasing their respiration rate, but birds and pigs only increase their respiration rate after the body temperature has started to rise.

European type cattle are only really productive in a climatic zone where the mean annual temperature falls below 65—70°F. (Wright, 1945) and little is known of the heat tolerance of zebu cattle though they are certainly more tolerant than European type stock. Pigs up to one hundred and fifty pounds liveweight thrive best at a mean temperature of 75°F (Heitman and Hughes, 1945). Little is known of the heat tolerance of goats, though some breeds thrive in the tropics.

It is possible that all animals can acclimatise themselves to some extent and that these long term adjustments are probably brought about by hormonal action. It is thought that the activity of thyroid decreases, and that this is probably controlled by the pituitary gland. This is probably one of the reasons for a decrease in reproductive ability which is apparent in Fiji though there is probably also a connection between reproductive ability and the small variation in length of day.

Apart from the animals acclimatising themselves it is possible to ameliorate climatic conditions. This can be done by the provision of shade, a plentiful supply of food and water close to the animals and if it can be economically justified the provision of water sprinklers and artificial methods of creating air movement. The logical method of satisfying these requirements is to keep the animals in semi-open yards and bring their food to them. In order to see whether this system is economically and technically justified the South Pacific Commission have agreed to help finance a new investigation on outdoor versus indoor feeding and management utilising eight sets of identical twins. This method of management may be particularly suitable for bulls, and we intend at Sigatoka to use a modified form of this system of management for the dairy herd. As soon as the new dairy is completed the dairy herd will be rotated on the pastures only at night, during the day they will be fed fodders in the yards where they will have access to shade, water, and feed.

At present our experimental work on acclimatisation is confined to European type dairy cattle. We are investigating the heat tolerance of our dairy herd, utilising Rhoad's heat tolerance test. Details of this work will be given during the paper on breeding. Secondly we are investigating the effect of a tropical climate on European type dairy cattle utilising eight sets of identical twins. This is a co-operative experiment with the Ruakura Animal Research Station in New Zealand and is partly financed by the South Pacific Commission. Briefly, the experiment is planned so that two groups of heifers of identical heredity are reared in Fiji and New Zealand under similar conditions of feeding and management.

Seven of the eight heifers at Sigatoka have now calved and it is possible to make some comparisons. Immediately prior to calving on the 30th of July the average liveweight of the eight heifers at Sigatoka, Fiji, was 845 pounds while at Ruakura New Zealand it was 937 pounds. Thus the heifers grew appreciably faster in a temperate climate, demonstrating that there is a physiological limit to growth in the tropics. A comparison of twin pairs (Table 1) shows that within pairs some animals grew very much better in Fiji than others. These animals would appear to be more "heat tolerant".

Of the greatest interest to the practical farmer is a comparison of these experimental growth rates with those normally obtained out on pasture in Fiji. If we remember that seven of the eight heifers are Jersey types, a small breed, that they are unselected, and that they were bred to calve down at two years, then an average live weight of 845 pounds at two years of age is very much above the average for Fiji. You may ask what this can be attributed to. I think that the answer is mainly amelioration of climatic conditions, but it may also be due to a rather higher plane of nutrition than is normal in Fiji.

TABLE 1.

LIVEWEIGHT OF HEIFERS 30/7/51.
Expressed as pounds.

Twin Pair.	Ruakura. (New Zealand)	Sigatoka (Fiji)	Difference Fiji from New Zealand
1	921	816	−105
2	776	754	− 22
3	1035	996	− 39
4	1050	868	−182
5	798	756	− 42
6	908	768	−140
7	1071	924	−147
8	933	876	− 57
Mean	937	845	− 92

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BREEDING STUDIES

By W. J. A. PAYNE

Breeding projects have been approved and are in operation for all classes of stock, with the exception of poultry at both of the Agricultural Stations in Fiji. At present the projects consist mainly of tabulating a large number of facts in the hope that some or all of these will be of some utility as the projects proceed..

It is usual and desirable to organise standard management and feeding practices when developing breeding projects but it will be readily understood that at the present stage of our development this is not possible and that it is necessary for us to plan ahead even though our management and feeding practices may alter.

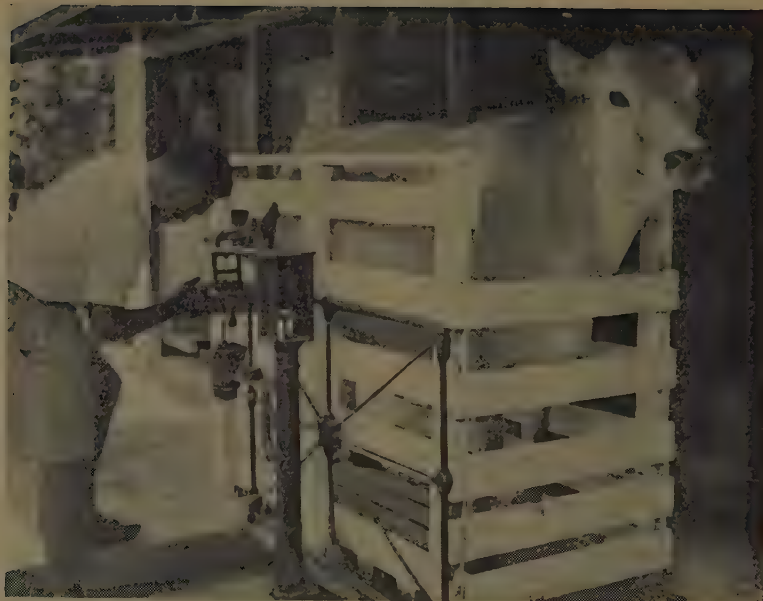
To-day I propose to deal with the breeding projects for dairy cattle, goats, and pigs separately.

DAIRY CATTLE.

As our acclimatisation studies show, there is a physiological limit to the rate of growth of dairy cattle in Fiji, so that there is every reason to believe that there is also a physiological limit to milk production. These physiological limits will come into operation even given optimal conditions of feeding and management but it is obvious that these optimal conditions are not even in sight in Fiji and so there is very considerable scope for improved breeding.

In formulating a breeding policy in Fiji we have three major choices. We can; (*a*) import highly productive European type cattle, select for heat tolerance, and ameliorate conditions, or (*b*) import heat tolerant Zebu cattle and select for milk production, or (*c*) import both European type and Zebu type stock, cross them, and attempt to stabilise high productivity and heat tolerance in a new breed.

The second choice is impossible in Fiji as we would have to import a large number of animals from those parts of the world from which importation is restricted by the quarantine regulations. Work on these lines is at present proceeding in Africa and India.



The heifers are weighed and measured weekly.

The heifers are fed exactly the same rations in Fiji and New Zealand and the lucerne hay has to be imported into Fiji.

Crossing has been tried in all parts of the tropical world in the past with limited success. A new beef breed the Santa Gertrudis, has been created in Texas and a new milking breed, the Montgomery Jersey, is to be registered in Jamaica. A cross between the Red Scindi and the Jersey is now being tried at Beltsville in America, and the first results show that this cross is of exceptional merit. It remains to be seen whether the cross can be stabilised. Work of this nature could not be done by Government as our herds are too small and the only organisation that could attempt anything of this nature in Fiji is the Fiji Pastoral Company.

The first policy is the only practical one for Government as there is quite a large reservoir of European type animals in Fiji, and large numbers of highly productive herds in Australia and New Zealand, and animals from these countries can be imported under the quarantine regulations.

You will want to know how far we have reached and what we are proposing to do in the future. The first step is to review what has happened in the past. A dairy herd has been maintained at the Sigatoka station for ten years. We have now assembled all the records and we are pleased to note that there has been a steady improvement in milk yield per lactation (Table 2). This increase can probably be attributed more to better feeding and management than to better breeding, though some part is due to the purchase of particularly productive stock.

We have been able to progeny test the two herd bulls used during this decade and I am certain that it will interest you to know that whereas the bull Turaga (XX10) increased the yield of his daughters over the dams the bull Noble (X18, A1) decreased it (Table 3). This exposes the fallacy of picking a bull by type.

So much for the past. What of future policy. We intend to select heifers for "heat tolerance" on the assumption that only "heat tolerant" stock can be really productive. If we first pick out the "heat tolerant" stock at an early age we can then cull for production after one lactation. We are using a method developed in America for "heat tolerance" testing stock. Last year most of the herd at Sigatoka were tested and this year the herds at both stations will be tested. After three or four years work we should be able to determine whether "heat tolerance" as determine by Rhoad's test (Rhoad, 1944) is (*a*) correlated with production (*b*) inherited, and,

TABLE 2.

PRODUCTION OF THE FRIESIAN HERD AT SIGATOKA (1941—1950).

Year	No lactations	Av. length of dry period (days)	Av. length of lactations (days)	Corrected yield (305 day) (lb.)	Animals producing more than 5,000 lb.
1941	3	?	207	1237	—
1942	9	178 (3)	243	2177	—
1943	7	141 (6)	238	2753	—
1944	11	123 (8)	269	3039	—
1945	11	63 (7)	293	3499	1
1946	14	57 (2)	280	3832	2
1947	8	89 (7)	254	4114	3
1948	22	86 (9)	265	4989	9
1949	18	73 (14)	249	5080	8
1950	25	167 (14)	260	5205	13

(Numbers in brackets in column three are the number of animals in the sample.)

(*c*) whether it changes with age or for other reasons. The data for 1950—51 is shown in Table 4. At the same time we are considering new methods of heat tolerance testing but this work is only in the first stages. A mixture of pedigree and non-pedigree Shorthorn heifers have been imported from New Zealand and they will be "heat tolerance" tested this year. This should give us some ideas as to whether, as we suspect, "heat tolerance" has the same distribution in pedigree and non-pedigree stock.

TABLE 3.

PROGENY TEST OF THE BULLS USED AT SIGATOKA, 1941-50.

Turaga (XX10) Corrected yield in first lactation (lb.)		Noble A1 (X18) Corrected yield in first lactation (lb.)	
Dam	Daughter	Dam	Daughter
3983	4177	7115	3961
2780	4166	7052	4441
2780	4382	4851	2629
2570	2768	4549	1464
2411	2998	4395	1614
763	3691	4116	3269
438	3226	3691	2888
		3226	3961
		2411	4304
		25	353

With regard to bulls we have imported a pedigree Friesian bull from Massey Agricultural College. This animal has a very good pedigree but it remains to be seen whether he is " heat tolerant " or not. Preliminary discussions are being made with the Dairy Research Institute in New Zealand with a view to seeing whether it is possible to arrange for the " heat tolerance " testing of this year's Friesian bull calf crop. If this is possible then the most " heat tolerant " bull will be purchased and imported to Fiji next year. We will also " heat tolerance " test our own bull calves and if we obtain a particularly good animal we will probably use it to practise a little line-breeding. That is we will cross him back to his dam and her sisters, or his own half sisters. We may sum up by saying that our policy is to " heat tolerance " test all our dairy stock, select our breeding heifers on the result of these tests and then either cross the selected heifers with a " heat tolerance " tested imported bull, or use a bull selected from the herd and line breed.

I must mention in passing the problem of sterility. I have seen enough of the country's herds this year to be convinced that sterility is of some importance. At this stage I do not know what it is due to, and it is a problem that we can investigate on the stations as our herds appear to be almost as badly affected as all the other herds in the country.

GOATS.

Our aim is to breed a suitable type of meat goat. Our policy is to purchase local does to form a nuclear herd and cross them with Angora bucks. The first kidding season has just ended.

The future breeding stock will be selected for rate of growth, mature weight, and conformation. Although we are breeding for meat, milk production is also important, as the rate of growth of the kid in the first three months of life depends to a large extent upon the milking ability of the doe.

TABLE 4.

RELATIONSHIP BETWEEN HEAT TOLERANCE AND PRODUCTION.

Grade Friesian herd at Sigatoka 1950.

No. of cow.	Corrected yield (305 day lactation) (lb.)	Heat tolerance coefficient after Rhoad 1944
A42	8243	76
A20	7762	65
A39	7585	86
A96	6928	83
A37	6782	74
A41	6195	76
A14	6110	58
A8	5859	73
A93	5538	77
A28	4861	71
A41	4774	76
A45	4304	69
A61	3961	67
A17	3781	66
A115	3574	72

Two breeding policies will be pursued simultaneously. First outcrossing ; the first cross goats will be crossed back to Angora bucks or to a third breed. Secondly one doe is particularly promising, she weighs over one hundred pounds liveweight, and her first cross kid, a buck, will be used for line breeding.

It is of some interest to note that the two Angora bucks which were imported in July 1950 were either impotent or sterile for the

first six months. This was not altogether unexpected as the bucks were moved from a long-short light period environment to one where the light periods are almost equal throughout the year. Recent work in Queensland (Moule, 1950) and at Cambridge (Yeates, 1949) has demonstrated the importance of light and its effect on the breeding cycle of sheep, and it is reasonable to suppose that goats are affected in the same way.

PIGS.

The Department has built up small herds of large White and Tamworth pigs at Sigatoka. This year two Berkshire boars and two gilts have been purchased in addition to Large White and Tamworth stock. The Large Whites will be kept at Koronivia and the Berkshires and the Tamworths at Sigatoka. Thus three pure bred breeds will be run at the two stations but first crosses will be made to investigate the possibilities of the first cross as a commercial pig.

Some details of litter numbers and weaning weight of the pigs at the Sigatoka Station are available for the four years 1947-1950.

TABLE 5

PROLIFICACY AND LIVEWEIGHT AT BIRTH AND WEANING OF THE PIGS AT SIGATOKA 1947-50.

Breed	Average No. born alive	Average weight at birth (lb.)	Average No. weaned	Average weight at weaning (lb.)
Large White	9.9	3.05	7.4	30.8
Tamworth .	7.1	2.98	6.4	24.0

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ANIMAL NUTRITION

BY W. I. LAING

Apart from working animals, our main livestock consist of cattle, goats, pigs, and poultry. Cattle and goats, together with sheep, are easily our most valuable farm animals as they are equipped with a large, highly specialised fore-stomach, which can convert fibrous feedstuffs into milk and meat. The digestive system of the pig is more similar to the human digestive system than to that of the ruminants, and pigs are to some extent direct competitors with ourselves for certain foodstuffs. The problem of pig nutrition will be discussed separately. Poultry nutrition will not be discussed.

Feedingstuffs are generally grouped into forages and concentrates. By far the most important of all our forage is pasture. Pasture comprises a cheap source of feed which can be fed to the grazing animals at very low cost. Apart from this very real advantage we should not lose sight of the fact that if it is properly managed pasture can provide a balanced diet for even highly productive animals. For example one farmer situated at Tai Tapu near Christchurch in New Zealand, averaged 500 lb of butter fat, or an equivalent of 1,350 gallons of milk from his Friesian herd for several years. The only fodder provided in addition to the exceptionally high quality pastures was lucerne hay and chou-moellier used to eke out the winter feed shortage when the cows were dry. Although this was an exceptionally well managed farm it is no exaggeration to say that few commercial dairy farmers in New Zealand ever feed concentrates to their dairy herd. This is in marked contrast of course to the accepted practice in Australia, America, or Great Britain where a greater or lesser degree of aridity and/or severe winters cause the complete cessation of pasture growth. In the driest areas insufficient hay and silage can be conserved to tide over the period of low production, and concentrate feeding becomes inevitable.

Our marine tropical climate with consistently warm weather and the absence of true drought conditions is ideal for grass growth and in this respect bears a much closer resemblance to Taranaki or the Waikato, than to Great Britain or the major portion of the Australian continent. It has long been assumed that our climate militates against the establishment of high quality pastures but our own views are markedly at variance

with this supposition. The problem here is, generally speaking, not one of poor plant growth but rather how best to utilise the pasture species while they are still immature and nutritious. Once we realise this, it becomes easier to reconcile the widespread prevalence of low grade pastures with the fact that we should be able to grow as good pasture as anywhere in the world.

The result of eighteen months pasture work strengthens our conviction that this hope may one day become a reality. One of our fields containing " a guinea-centro " (*Panicum maximum-Centrosema pubescens*) pasture has yielded nearly twenty tons of young leafy material in the last twelve months. During that time it has supported more than an equivalent of one productive dairy cow per acre. In managing this field we were deliberately trying by light but frequent grazings to produce high quality feed for the milking herd: the high bulk of forage produced was to some extent incidental. When we consider that the " Ryegrass-white clover " pastures at the Grassland Division at Palmerston North yield this same quantity of forage you can see that our climate is not really unfavourable to high grassland production.

Qualitatively we feel that the best temperate pastures are still superior to our own, but we have good reason to believe that the pasture quoted above was much better than is normal for the tropics. One analysis of young " Guinea " (*Panicum maximum*) at this station revealed the same crude protein value of 10.9 per cent as Cartmill (1944) gives for it in Queensland. Mature " Centro " (*Centrosema pubescens*) from Naduruloulou in Fiji has been analysed as having 17.4 per cent crude protein (Parham, 1948), although Hutchinson (1941) working in New Guinea gives it the somewhat higher value of 20.9. We would probably not be far wrong if we assumed an overall value for the pasture of 12 per cent which would give an annual yield of 1,500 pounds of crude protein per acre. This is much higher than the figure of 800 pounds given for high quality pastures in England by Slade (1951) in a recent paper.

From the end of June to the beginning of August the dry herd was running on pastures which could scarcely have been grazed any lower. In spite of this treatment they looked as well as they have ever done before. The only simple explanation of this is that at a time when the grasses are normally stemmy and dormant the severe grazing removed all the mature stems, leaving only the young leaf tips to be eaten. Although grass yields were undoubtedly low it is more than likely that the digestibility coefficient and protein percentage were both exceptionally high. The lesson would appear to be that we have to change our management and perhaps our pasture species so that we can graze still closer.

Brief mention has already been made of the enormous seasonal variation in pasture growth. Our pilot studies on grasses and legumes give us objective evidence of the extent of this and some idea of how the different species vary amongst themselves. " Guinea " (*Panicum maximum*) is one of our highest producing grasses but its variation is one of the greatest. For the four quarters beginning in May, August, November and February the percentages of the total annual production grown in those periods were 8, 20, 44 and 28 respectively. " Nadi Blue " (*Dicanthium caricosum*) although giving much less bulk had a much better distribution throughout the whole year, the comparable percentages being 21, 23, 33 and 23.

This variation poses some real problems for the farmer especially if he has no option but to try to maintain all the year round milk production. We do have some suggestions, however, to offer him. He can conserve some of the surplus feed of the late dry season ; he can spell some of his fields at the end of the wet season and then graze them during May, June, and July or he can establish pastures or other fodder plants in April so that the establishment flush of growth coincides with the low production of the older pastures. At present the best means of fodder conservation would appear to be the making of silage. We discussed this question fully at our Field Day last September and all we would like to do now is to remind you that good quality pasture or other forage can be conserved in a pit or stack by the exclusion of air and the addition of molasses. Lower quality silage, which may be used as a maintenance ration

The twenty-three month old heifers used in the twin experiment coming into feed, July, 1951.

Two calves, one showing typical symtons of parasitic infection. The smaller calf was born one day before the larger animal, and both were reared under exactly the same conditions.

may be made out of a large variety of materials including lower grade pasture and sugar cane tops. At present in the cane areas much of this material is being incompletely utilised.

The second important group of forages is the fodders, that is to say, the large grasses and legumes which cannot be grazed in the normal manner, and usually require special cultural management. It is equally important they should be fed in the young leafy stage. Unfortunately the same marked seasonal fluctations obtain as with the pastures. As full use is still not being made of fodders in Fiji, we list the more common ones for the benefit of those who may be unfamiliar with their identity. The most useful grasses are "Elephant" (*Pennisetum purpureum*, "Guatemala" (*Tripsacum laxum*), and "Kavirondo Sorghum" (*Sorghum verticiflorum var.*), the best legumes "Vaivai" (*Leucaena glauca*), "Desmanthus" (*Desmanthus virgatus*), and "Pigeon Pea" (*Cajanus cajan*). These last three are extremely rich sources of protein, "Vaivai" (*Leucaena glauca*) leaves for example having a crude protein analysis of 22.7 per cent (Henke, 1943).

We are far from certain what part the concentrates should play in our rations. Imported feeds are very costly and supplies are frequently unavailable from both New Zealand and Australia.. Some concentrates such as peanut meal are much richer in protein than the forages, and on account of their small bulk can be fed to supplement otherwise unbalanced diets. We have some evidence to suggest that heat intolerance may depress the animal's appetite, and palatable concentrates may be needed to maintain production. We think, however, that this is the wrong approach. It would appear much better to eliminate heat intolerance by breeding, ameliorate the climate by special management practices, and improve the palatability and feed value of our pasture so that it can be ingested in quantities sufficient to maintain production. The most readily available protein meals are peanut meal with a nominal crude protein value of 40 per cent, coconut meal with a considerably lower value of 18 per cent (Morrison, 1947) and candlenut meal which has been fed to dairy stock in Tahiti with some success, (Private communication, 1951). Molasses is a cheap energy food which may be used in small quantities to improve the palatability of concentrate or soilage rations, maize and rice bran may be fed as energy supplements, but the former is costly and the latter has a very variable composition, the poorest samples having very low digestibility coefficients. Pineapple bran is another feed which could be made available at certain times in limited quantities.

The possibility of drying "Vaivai" (*Leucaena glauca*) leaflets and pressing them into cakes, as is being attempted in Hawaii, would appear to be one way of supplementing our present inadequate supply of protein. With a crude protein percentage of 20 the feeding value of the cakes would be more than comparable with coconut meal.

In evaluating any rations the nutritive ratio or relative proportions of protein and carbohydrate must be borne in mind. A narrow ratio, or relatively large proportion of protein is required by all young growing animals and highly productive dairy stock. Bulk in itself may not aid production. For example, if a diet of stemmy "Para" (*Brachiaria mutica*) is already low in protein the supplementary feeding of rice bran and molasses will only aggravate the position and render the small amount of dietary protein even less available.

Water and minerals are essential to all animals, and it seems likely that temperate zone feeding standards underestimate the needs of animals in the tropics. During hot weather dairy animals need large quantities of water, and a plentiful supply preferably cool, at all times is essential. The mistaken belief that tropical grasses contain large quantities of water is quite wrong, if anything the dry matter content of our grasses is higher than in more temperate countries. Common salt too should be freely available as there is some evidence that this also is needed in large quantities. As far as other mineral supplements are concerned we have no evidence to support the belief that composite mineral supplements are necessary. If specific deficiencies are demonstrated there are cheap compounds that can be

mixed with the concentrates. The use of proprietary licks is generally inadvisable as complete analyses are seldom given and the compounding costs and trade profits far outweigh any advantages.

Pig nutrition is quite different from ruminant in so far as they are not able to digest and utilise very fibrous foods. We have to resort to the feeding of roots, grains, and other concentrate feeds. Roots are definitely the cheapest bulk suppliers of energy and the ration should consist largely of tapioca, kumala or similar roots plus some green forage. We have been successful in demonstrating how tapioca can be stored until it is required. The method consists of cooking fresh roots and then ensiling them in a pit. The digestibility is improved, any slight risk of cyanide poisoning is reduced, and the tapioca should keep indefinitely. Three tons of this feed were made on the farm last year.

The main nutritional difficulty in pig raising is in the provision of an adequate supply of cheap protein feeds of the correct quality. Growing pigs require some protein of animal origin. Peanut meal is easily the cheapest protein feed available and it can be supplemented with coconut meal. But it is difficult to obtain suitable protein concentrates of animal origin. The farmer who has skim, buttermilk, or slaughterhouse offals to feed is a lucky man and has little to worry about in this respect. We have in view a project to find the most economical and satisfactory local source of animal protein, or the essential factors occurring naturally with animal protein, and we hope to find a solution to this problem. As an interim measure it may be possible to purchase a small amount of imported meat meal in the near future. All that we can say to the farmer without cheap milk, grains or concentrates is that we must feed certain minimal amounts of concentrates, e.g. 2.2 pounds daily for pigs with a live weight of 60 pounds including at least one third protein-rich concentrates. The remaining bulk can be made up with roots and forages.

In conclusion we might say that the outlook for the pastoralist in Fiji is quite promising. With new management techniques and a better appreciation of the need to graze the pasture while it is still immature the farmer has the prospects of large quantities of nutritious feed readily available for his cattle, sheep, or goats in the not too distant future. The pig raiser is in a much less favourable position, but even he should find some encouragement in current advances in the science of nutrition taking place oversas.

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INTERNAL PARASITES OF CATTLE AND GOATS IN FIJI

BY K. J. GARNETT

This station is primarily concerned with the better feeding and breeding of livestock. However, it is of little use improving a pasture or carrying out costly breeding programmes if the parasite story is neglected. Admittedly, the improvement of the plane of nutrition will help animals to combat parasites, but even with our present advances it is going to be some time before our pastures have reached the stage where they can provide sufficient nutriment adequately to feed the beast and the parasite. As far as breeding is concerned, the potential champion is of little use if it is killed in early life by parasites or if it receives such a setback that it just does not grow into the champion that its hereditary make-up renders possible.

This may seem a gloomy picture, but those of you with any experience of stock in this Colony will agree that it is all too true. Worms are one of the most important direct factors contributing to low production in the Colony and while a lot of the answers cannot be supplied, it is hoped that this

paper will serve to give you a better appreciation of the position and enable you to take steps which will minimise the effects of these " profit thieves ".

Most of you are familiar with the symptoms of a heavy worm infestation :—unthriftiness, anaemia, diarrhoea, rough coat, sunken eyes, bottle jaw, weakness and death in extreme cases, and there is no need to spend time describing these symptoms in detail.

Firstly it must be understood that there are many types of worms and that in many cases they are most particular about the animal they live in, e.g. the nodule worm (*Bosicola radiatum*) will live only in cattle, while very similar worms, *Oesophagostomum venulosum,* will live in sheep, goats and deer but not in cattle, and a third worm *Oesophagostomum dentatum* lives only in the pig. All these worms are very similar and even an experienced parasitologist requires the aid of a microscope to differentiate between them. It is interesting to note, however, that all three worms occupy the same position in their respective hosts' alimentary tract, the colon.

Other worms are a little less particular and will live in practically any ruminant animal so that infection can be passed from sheep to cattle or goats. However, worms of this class would not live in other grass eating animals such as the horse. These points are of paramount importance in adopting control measures.

It is comforting to note that with few exceptions, none of the parasites found in cattle and goats are transmissable to man. Fortunately for Fiji, these parasites are not often seen in the Colony.

Types of Internal Parasites.

I have already mentioned that parasites are not only host specific in most cases, but that they are most particular about the part of the animal's body in which they take up residence.

Haemonchus Contortus, or the Barber's Pole worm, are mainly found in the fourth stomach but may also be found in the first few feet of the small intestine. They are about one inch to one and a quarter inches long and the female has a characteristic spinal stripe.

Cooperia spp., or Small Intestinal worms, are found mainly in the first ten or twelve feet of the small intestine. They are about three-eigths to one-half inch long.

Ostertagia, Brown Stomach worms are found in the fourth stomach. They are one-half to five-eigths of an inch long.

Trichostrongylus, Hair worm or Black Scar worm, are found in the fourth stomach and first part of the small intestine. They are very slender and about one-quarter of an inch long.

Bunostomum, Hookworms, are found in the first few feet of the small intestine. They are about one inch to one and a quarter inches in length.

Bosicola and Oesophagostomum,, Nodule worm, is found in the colon or large bowel, it is a relatively stout worm about three-quarters to one inch in length.

Trichuris, Whipworms, are found in the cæcum or blind sac of the large bowel. They have a characteristically slender anterior portion and thicker posterior from which the name is derived. They are about two to three inches in length if straightened out, but the thick portion measures only about one-half of an inch.

Dictyocaulis, Lungworms, are found in the air passages of lungs. They grow up to one inch in length.

Setaria labiato-papillosa, filarial worms, are found free in the peritoneal cavity. They are between three and five inches long but are not of any pathogenic significance.

Cotylophoron cotylophorum, Stomach or Conical flukes, are found in the first and second stomachs. They are bright pink in colour and about a quarter of an inch long. Reports indicate that the adult flukes do little harm but the young flukes, which pass part of their time in the small intestine before going on to the first and second stomachs,may cause severe diarrhoea.

Most of the worms have a direct life cycle. Worms included in this group are *Hæmonchus, Cooperia, Oestertagia, Trichostrongylus, Bunostomum, Trichuris* and

Bosicola or *Oesophagostomum*. Briefly the adult worms in the gut lay eggs which pass out with the fæces and hatch out into small larvæ which undergo certain developmental changes before reaching the stage where they could grow to adult worms if again eaten by a suitable animal. These stages occupy five days to several weeks depending on climatic conditions, and it is here that rotational grazing can play a major part in control measures. After being eaten the young larvæ rapidly grow to maturity in as short a time as three weeks. Exceptions are (*a*) *Dictyocaulis,* where the eggs are laid in the lungs and may hatch there, but usually the eggs are coughed up and swallowed and hatch while passing through the alimentary canal and moult in the soil. They are reswallowed and in three days burrow through the wall of the intestine and into the mesenteric lymph nodes where they have a final moult and then pass via blood or lymph vessels back to the lungs (*b*) *Setaria labiata-papillosa* where the life cycle is passed partly in the peritoneal cavity and partly in a blood sucking insect such as the mosquito and (*c*) *Cotylophoron* where the eggs pass out with the fæces and hatch into " miracidia " each becomes a sac-like structure called a " sporocyst " and this in turn develops into a " redia " and finally escapes from the snail, grows a tail with which it swims about and is known as a " cercaria ". The cercaria which is infective if swallowed, usually finds a suitable blade of grass, sheds its tail and becomes encysted until the animal ingests it, when it grows into a small fluke in the duodenum and then passes up to the reticulum and rumen.

CONTROL MEASURES AGAINST INTERNAL PARASITES.

There are two methods of attacking parasites. The first is a direct attack on the worms in the stomach or intestine, with one of the drugs recommended below. The second is to prevent reinfestation of the animal by breaking the cycle while the parasite is undergoing development and it is here that rotational grazing is so useful. Generally speaking, the eggs start to become infective larvæ about five days after passing out with the fæces so that if the stock are moved off the field at the end of a week very few of the eggs passed will have hatched or developed to the infective stage. Under ideal conditions of shade and moisture some of the larvæ can live for several months, but under natural conditions lots of them quickly die, particularly if exposed to sunlight and dryness. The aim should accordingly be to have at least four paddocks so that each paddock is used for not more than a week and then spelled for a least three weeks before being used again.

It will be found that a combination of drenching and intelligent rotational grazing will control parasites in the majority of cases.

It should also be remembered that older animals develop a resistance to the effects of a worm infestation and in some cases to actual infestation. However, the young animal is most susceptible and for this reason it is bad husbandry to run young and old stock together in the same paddock as the apparently healthy older stock are infecting the younger and very susceptible young stock. If the same paddocks must be used because of lack of fencing, then the young stock should be rotated ahead of the older stock.

In the case of young goats which are to be run with their dams care should be taken that the does are treated before kidding in order to reduce the risk of later infecting their young. Does can be drenched some three weeks before kidding if they are quietly handled. All stock run together in the same paddocks should be drenched together and if possible put out on to clean paddocks after drenching. If these two points are not adhered to reinfestation will almost certainly follow. Phenothiazine has been found to be the most suitable drench and a pamphlet dealing with its use is available for those interested.

INVESTIGATIONAL WORK ON INTERNAL PARASITES.

Obviously, one cannot always kill an animal to see the type and numbers of worms present in it. Accordingly alternate methods are used in which samples of fæces are examined microscopically to determine the worm eggs present. This count is quantitative so that an estimation of the numbers of eggs being produced each day can be made.

Some of these eggs can be differentiated as having been produced by specific worms, but in some cases it is necessary to incubate the eggs and to differentiate the larvæ which hatch out to find out how many eggs have been laid by each type of worm. The different egg laying capacity of each type of worm is approximately known and so a fairly reliable estimation of the type and numbers of each worm present in any animal can be made.

In Australia, particularly with sheep, a vast store of knowledge has been built up regarding the seasonal incidence, age susceptibility and pathological levels of infestation. From this knowledge a very accurately timed and efficient drenching programme has been evolved.

A less elaborate scheme to determine these same important points has been approved by the Research Committee of the Department, but, unfortunately, lack of veterinary staff has necessitated the shelving of this very important project. In the meantime, some interesting details are being supplied by Dr. Roberts and his co-workers in Queensland, but while conditions here are similar in many ways, it is imperative that problems of this nature must be worked out on the spot as there are so many small local factors which can entirely alter the picture.

LIVESTOCK MANAGEMENT

BY W. I. LAING

Of the various papers presented to-day this one deals with the greatest diversity of topics, some of them of minor importance, but collectively comprising the most practical, and hence, to the farmer, the most utilitarian of all. It is one thing for us to prescribe rations and breeding policies for animals in Fiji, or to describe the prophylaxis and treatment of the various ailments which they encounter : it is quite a different matter for the farmer to try to adjust the feed supply to suit the animals' requirement, to see that the pastures are free from parasites, to anticipate sickness in the flock or herd before it becomes apparent, to decide on which animals to sell and which to retain for breeding, in short to translate the theories of animal husbandry into the harsh realities of every day farming. Whereas breeding, nutrition, and acclimatisation have the supporting science of genetics, biochemistry, and physiology, livestock management has only the skill, resources and determination of the farmer himself. No set of weather, feed, or breeding conditions ever recur, and hence it is the farmer alone who can apply the information which the experts in the wide variety of fields have to offer him. This success cannot be measured in terms of standard errors or tests of significance, financial considerations eclipse all other factors to such an extent that only the farmer himself can assess the real value of the various techniques and practices.

We have already dealt in previous papers with the feeding of our dairy cattle. We cannot attach too much importance to the need for the close control of the animal on the pastures. The rapid movement of the stock over the fields ensures large amounts of high quality feed and a large measure of freedom from internal parasites, and the pastures can be kept short without the destruction of the valuable component species. Behaviour studies have shown that the most suitable time to graze is in the evening, night, and early morning.

So far as possible milking times should be arranged so that the animal can spend the maximum time on the pasture during this part of the twenty-four hours. Animals prefer " loafing " in the heat of the day and should never be driven long distances at this time. They should, however, have free access to salt, shade and water.

It seems quite likely that indoor feeding may have advantages to the man with limited land, or to the farmer who frequently has waterlogged grazings. We cannot be too sure ourselves yet, but we suggest that farmers who experience regular poaching of the pastures and whose cows have perpetually mud-caked udders should try feeding silage and green-feed to their milkers either in dry yards or in the shed. Even for those who can turn their herd on to dry areas at night it might well pay to feed highly palatable forages such as " Vaivai " (*Leucaena glauca*) or " Elephant Grass " (*Pennisetum purpureum*) during the day. At present low intake frequently reduces potential production and it is more than likely that any in-

crease in intake will be reflected in increased returns.

Milking techniques themselves are of course important. The " let-down " of milk is largely a conditioned reflex and in our milking routine the same sequence of operations should be closely adhered to, so that this reflex is not upset. Hand milkers should not be changed too frequetnly, as the cows and the milkers soon get to understand their mutual idiosyncrasies. On the larger farms hand milking is probably no longer economic and fortunately there are milking machines available to-day that are mechanically simple, easy to assemble and easy to clean. We hope to be able to say more on this very important topic at a later date when our own experience will be made available to you.

Successful pig rearing in Fiji is impossible without the provision of concrete. Most of you are aware of the ubiquitous nature of the Kidney worm. Cement enables frequent and easy cleansing of fæcal material and soiled food, and the risk of infestation with the parasite is greatly reduced. Older stock may be rotated systematically, by folding them carefully over fields which are to be ploughed up.

The electric fence is useful for this operation. It is advisable to move the pigs on to a fresh area at the end of two weeks. The method of folding is a cheap way to harvest a second crop of kumalas, or to clean up after the main crop has been lifted. A portable shelter is advisable and access to water is essential at all times of the year.

Creep feeding is the provision, by one means or another, of a special concentrate ration to the suckling pigs, given so that the sow cannot interfere with the young pigs while they are eating. At Sigatoka we have made special pens attached to the back of the farrowing pens and connected to them by small openings. As soon as two weeks after birth young pigs will commence eating solid foods and if they are used to their concentrates the post-weaning check in growth rate is virtually eliminated. It is also important where a sow has a large litter but a poor milk supply, the creep feed partly compensating for the indequate quantity of milk. Creeps can be constructed in any pens quite inexpensively.

Many pig raisers contend that all pigs require a wallow in the tropics. Certainly the need for some means of keeping the body cool when the air temperature is over 85°F. would appear obvious, but unfortunately there are two main objections to concrete wallows, they are either communal or costly. We are trying out an alternative which is cheaper and we hope just as satisfactory. By providing very fine sprays on every pen which can be turned on whenever it is very hot we hope to be able to keep the pigs cool and contented. What little experience we have gained in this unusually cool season is that the pigs fully appreciate this innovation.

The goat having been evolved in arid areas poses special problems for the farmer in the humid tropics. A rainproof shelter is essential, the hooves require regular paring, and monthly drenching with phenothiazine is necessary to eliminate parasites. Rank growth is entirely unsuited to goats but otherwise they are most accommodating feeders utilising many weeds in their diet.

If goats are continuously wet they become very unthrifty, so immediately prior to the onset of the rainy season all the feed close to the shelters should be conserved for the time when dry grazing periods are limited. During continuously wet weather the provision of supplementary fodder, given under shelter would appear to be desirable.

It should be obvious to everybody that kidding at definite predetermined times of the year automatically implies the isolation of the bucks from the flock except during the breeding season. All unwanted males should be sold or castrated before puberty. We use the " elastrator " on our own flock and the simplicity of this bloodless operation should appeal to the majority of goat raisers.

Goats are, of course, the most difficult farm animals to control but our own efforts aimed at first quietening down the flock by frequent yet careful handling, together with provision of adequate feed and very good fences have indicated that the problem is not insoluble. With the present prices for goat meat prevailing in the Colony a considerable capital outlay on housing and fences can soon be recouped, and the flock managed on sound lines.

PRODUCE (IMPORTS AND EXPORTS FOR 12 MONTHS ENDING 31ST DECEMBER, 1951

	Quantity	New Zealand		Australia		Other Countries		Total Value	
		Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
IMPORTS.	lb	£F	£F	£F	£F	£F	£F	£F	£F
Fresh Fruit—									
Australia	47·9	....	4,682	....	....	....	....	4,682	....
New Zealand	85·3	7,950	....	....	....	....	....	7,950	....
Garlic—									
Australia	72·4	....	....	10,331	....	....	....	10,331	....
New Zealand	55·0	7,046	....	....	....	....	....	7,046	....
China	4·0	....	....	....	....	616	....	616	....
Onions—									
Australia	57·03	....	....	2,430	....	....	....	2,430	....
New Zealand	732·4	....	....	....	....	....	....	42,014	....
Canada	142·0	....	....	....	....	9,192	....	9,192	....
U.S.A.	61·0	....	....	....	....	3,365	....	3,365	....
Potatoes—									
Australia	168·7	....	....	6,269	....	....	....	6,269	....
New Zealand	1,452·45	44,325	....	....	....	....	....	44,325	....
Canada	107·0	....	....	....	....	6,423	....	6,423	....
U.S.A.	16·0	....	....	....	844	....	....	844	....
Vegetables—									
Australia	16·0	....	....	1,498	....	....	....	1,498	....
New Zealand	40·8	2,758	....	....	....	....	....	2,758	....
Spices—	lb								
Australia	76,716	....	....	6,549	....	....	....	6,549	....
New Zealand	66	27	....	....	....	....	....	27	....
India	275,079	....	....	....	....	24,322	....	24,322	....
Ceylon	1,323	....	....	....	....	48	....	48	....
Br. East Africa	2,683	....	....	....	....	198	....	198	....
Other Countries	31,485	....	....	....	....	3,932	....	3,932	....

PRODUCE (IMPORTS AND EXPORTS) FOR 12 MONTHS ENDING 31st DECEMBER, 1951—(*contd.*)

	Quantity	New Zealand		Australia		Other Countries		Total Value	
		Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
EXPORTS.	lb	£F	£F	£F	£F	£F	£F	£F	£F
Bananas c/s—									
New Zealand ..	157,173	....	128,565	....	....	....	....	....	128,565
Pineapples c/s—									
New Zealand ..	167	....	109	....	....	....	....	....	109
Mixed Fruit—									
New Zealand ..	384	....	274	....	....	....	....	....	274
Peanuts sks.—									
New Zealand ..	640	....	2,621	....	....	....	....	....	2,621
Samoa	536	....	....	....	....	....	1,785	....	1,785
New Caledonia ..	48	....	....	....	....	....	160	....	160
Green Ginger c/s—									
New Zealand ..	236	....	236	....	....	....	....	....	236
U.S.A.	126	....	....	....	....	....	126	....	126
Dried Ginger—									
U.S.A.	12	....	....	....	....	....	144	....	144
Water Melon only—									
New Zealand ..	1,846	....	364	....	....	....	....	....	364
Arrowroot c/s—									
New Zealand ..	38	....	72	....	....	....	....	....	72
Taro c/s—									
New Zealand ..	1,544	....	1,082	....	....	....	....	....	1,082
Sundry Vegetables—									
New Zealand ..	198	....	170	....	....	....	....	....	170
Mixed Veg. c/s—									
New Zealand ..	66	....	51	....	....	....	....	....	51
Sundry Fruit c/s—									
New Zealand ..	314	....	225	....	....	....	....	....	225
Coconuts sks.—									
New Zealand ..	9	....	8	....	....	....	....	....	8
Rice Bran sks.—									
New Zealand ..	5,199	....	3,597	....	....	....	....	....	3,597
Oranges c/s—									
New Zealand ..	13	....	10	....	....	....	....	....	10
Peanuts sks.—									
Tonga	15	....	....	....	....	....	50	....	50
Coconut Meal tons—									
New Zealand ..	3,328·8	....	58,649	....	....	....	....	....	58,649
United Kingdom ..	1,848·0	....	....	....	....	....	30,704	....	30,704
Tahiti	27·0	....	....	....	....	....	461	....	461
B.S.I.P.	·5	....	....	....	....	....	9	....	9
Tonga	1·0	....	....	....	....	....	19	....	19
Line Is.	·4	....	....	....	....	....	7	....	7
New Caledonia ..	60·0	....	....	....	....	....	1,297	....	1,297
Copra tons—									
United Kingdom ..	15,375·4	....	....	....	....	....	900,925	....	900,925
Coconut Oil—									
United Kingdom ..	104,69·8	....	....	....	....	....	1,033,863	....	1,033,863
	104,120	196,033	31,759	....	48,940	1,969,550	1,848,192	165,583	....

The following commodities are not included:—Flour, Sharps, rice and sugar.

C. R. VASEY,
Produce Inspector.

CHEMISTRY NOTES . . .

THE FERTILIZER VALUE OF LAU (OGEADRIKI) PHOSPHATE

Fiji has within its boundaries a phosphate fertilizer deposit which, if it could be shown to be of real agricultural value, would be worth about half a million pounds to the Colony.

The deposit, which has been estimated to contain 80,000 to 200,000 tons, is loamy in nature and can be filled directly into bags or other containers, since it lies on the surface without over-burden. Practically the whole of a sample taken by L. E. Smythe in 1948 was found to pass through a 35 mesh sieve. The phosphate content of this sample was 20.5% P_2O_5, equivalent to 45% calcium phosphate. Other samples taken by the Government Mining Engineer (F. F. W. White) and by G. J. Bridges of the British Phosphate Commission averaged 26% and 27% P_2O_5 respectively.

Unfortunately, although the phosphate content is reasonably high, the deposit has a large content of iron and aluminium and it is this fact which throws some doubt upon the agricultural value of the phosphate compared with the more common rock phosphates which occur throughout the world.

Four samples taken by Bridges showed the following mean values:—

Fe_2O_3	Al_2O_3	P_2O_5	CaO	
10	20	27	22	% of total sample.
0.33	1.03	1.00	1.37	Chemically equivalent values ($P_2O_5=1$).

This analysis shows not only a large amount of aluminium and iron but also that there is more than sufficient to combine with the whole of the phosphate. In other words there may be very little of the usual (more soluble) calcium phosphate present at all. Tests in this laboratory have confirmed the insolubility of the phosphate present: only about 1% of the total phosphate is soluble in dilute citric acid whereas the best rock phosphate is almost completely soluble.

Reducing the size of the phosphate particle does not help appreciably. Material which had been ground to pass a sieve having 150 meshes to the inch was not much more soluble than the unground sample.

It must therefore be concluded that unless some process can be found for treating the phosphatic material so as to render the phosphate less insoluble (it is quite unsuited for superphosphate manufacture) the high content of phosphate cannot be effectively used in agriculture.

This opinion is confirmed by such experimental work as has already been carried out in the field.

	Location and Soil	Crop	Experiment	Results
A6/48	Alluvial flats, Navua ..	Pasture ..	Factorial	Small response to Super. No response to Lau.
	Sangram Estate, Ra ..	,, ..	Observational only ..	Good apparent response to Super. No apparent response to Lau.
	Uciwai	,, ..	,, ..	,,
	Togobula and Lomawai .	,, ..	,, ..	,,
X1/49	Vatia Point	,, ..	,, ..	Apparent response to Super. No apparent response to Lau.
	Korovuto	,, ..	,, ..	Slight apparent response to Super. No apparent response to Lau.
	Sarava, Ba	,, ..	,, ..	No apparent response to Super. No apparent response to Lau.
	Tailevu(2)	,, ..	,, ..	,,
A18/49	Hill land, Principal Agricultural Station	,, ..	,, ..	No response to Super. No response to Lau or to ground Rock Phosphate.

Although the dressings of Lau (Ogeadriki) Phosphate were not particularly heavy*, the fact remains that in not one instance has a response been recorded.

The following are possible methods for increasing the solubility of Lau phosphate.

(*a*) By fine grinding.

(*b*) By composting with waste residues which contain certain organic acids (citric, oxalic, tartaric, acetic).

(*c*) By using the anærobic conditions prevailing in a paddy field it may be possible to render part of the phosphate soluble through the formation of ferrous phosphate.

Brief laboratory trials have been made to test methods (*a*) and (*b*) without any promise of success. Method (*c*) might well prove Lau phosphate to have an economic value in this specific usage but only experimentation can show. Staff is again the limiting factor.

—N.G.C.

* 12 cwt./acre for Factorial Experiment and 4 cwt./acre annually for the others.

THE POTASH STATUS OF COCONUTS ON VITI LEVU

During a recent tour of Viti Levu the Senior Chemist undertook a rapid reconnaisance survey of coconut palms encountered *en route*. Time did not permit much deviation from the main road, but as a watch was being kept for unhealthy palms, any nutrient deficiency, including potash, should have been well represented in the samples which were taken.

Forty nuts, from 15 palms, were collected. The palms were usually selected in pairs representing poor and average health. The following table lists the palms which were sampled.

	Locality	Variety	No. of Nuts	Leaves	Appearance of palm.
1	Vunidilo .	Tall	1	14	Yellow: very poor
2	(Sea front)	Tall	Many	22	Average
3	Sigatoka–Cuvu	Tall	32	22	Average
4	(Coral shell and limestone soil)	Tall	7	20 (4 dead)	Restricted growth.
5	Ba–Natunuku	Tall	4	few..	Yellow: poor
6	(Border of tidal area)	Tall	Nil	Very few	Yellow: stunted and very poor
7	—Natunuku (Edge of tidal swamp)	Tall	Many	Many	Green and healthy.
8		Tall	Many	Many	Average green:
9		Tall	Many	Many	
10	Korovou (Tavua)	Tall	Many	Many	
11	(Low lying area)	Tall	4	Few	Yellow: very poor.
12		Tall	4	Few	
13		Tall	4	Few	
14	Sigatoka (A.S.S.)	Dwarf	....	Many	Yellow (new leaves green)
31		Dwarf	....	Many	Average for dwarf variety

The potash status of the coconut palm has been measured by Salgado, working at the Coconut Research Estate Ceylon, by a quick method involving the estimation of potassium in water from the nut. The work of Salgado, althought restricted to experiments on two soils, suggests that the following criterion might be used as a guide.

Palms very deficient in potash	1.00 g.	K_2O per litre of Coconut water.
Palms on border line	2.00 g.	
Palms amply supplied	2.5 g.	

Analyses for the nuts sampled on Viti Levu are given below.

Origin.	Potash in nut water (K_2O g/e)				Mean	Appearance of Palm
	a	b.	c.	d.		
1 Vunidilo	No	water	in	nut	....	Very poor
2 ..	3·06	3·00	....	....	3·03	Average
3 Sigatoka–Cuvu	2·00	1·80	2·34	1·84	2·00	Average
4	2·30	2·54 2·46 2·58	....	....	2·47	Restricted growth
5 Ba–Natunuku	1·93	2·14	....	....	2·04	Poor
6	No	nuts				
7—Natunuku	3·12 2·81	....	....	....	2·96	Green and healthy
8 ..	2·66	3·20	3·14	....	3·00	Average
9	3·23	3·11	3·50	3·78	3·40	Average
10 Korovou (Tavua)	3·26	3·49	3·10	3·11	3·32	Average
11	2·92	3·45	....	....	3·18	Very poor
12	3·90	3·20	....	....	3·55	Very poor
13	2·56	....	....	....	2·56	Very poor
14 Sigatoka (A.S.S.)	2·83	3·00	2·81	2·45	2·77	Yellow
31	2·98	2·45	2·95	2·91	2·82	Average
Suva Market (random purchases)	2·45	....	....	....	2·45	Unknown
	3·02	....	....	....	3·02	Unknown
	1·10	....	....	....	1·10	Unknown
	2·98	....	....	....	2·98	

NOTES.—1. The letters a, b, c, d, refer to nuts from separate rachis.

2. In general "a" refers to the oldest and "d" to the youngest; but field errors were known to occur in respect to the sequence for any particular palm.

CONCLUSIONS.

On the basis of Salgado's findings there is not much indication of potash deficiency in the particular palms sampled. Only two values were found less than the border-line figure of 2.0 g. K_2O per litre of coconut water; and in most cases the values exceeded the figure above which any additional response to potash fertilizer would not be expected.

As a corollary, the yellowed appearance which was observed in many palms does not seem to be associated with potash deficiency.

Of four nuts bought at random on the Suva Market, one indicates possible deficiency of potash and the others show good supplies.

From the information at present available the following tentative conclusion appears to be warranted: potash deficiency in coconuts may exist on Viti Levu but it is not widespread.

FURTHER WORK.

The usefulness of the Salgado method of testing is obvious. It provides a more direct and labour-saving method than soil analysis and it should be free of some of the objections to soil samples, e.g. when transport across water is necessary. The nut provides its own sealed container and once it is indelibly marked nothing short of splitting the shell can harm the sample.

When sufficient staff is available a testing service could be set up in which the plantation owner would need the minimum of instructions for sending in his own samples.

The present survey could also be readily extended to other parts of Fiji, wherever there is a local produce market.

—N.G.C.

A RECONNAISANCE SURVEY OF LIMING MATERIALS ON VITI LEVU

Object and Scope.—The object of the Survey was to review the sources of supply that have easy access, and to determine the quality of the material available.

All of these sources are at present being worked, though not all of them for agricultural purposes ; the question of ability to draw on these sources is not considered relevant to this report.

At least two sources were not sampled. Both are being used by the C.S.R. Company for the cane fields ; they are coral sand at Malomalo near Cuvu, and coral mud dredged from Suva harbour.

As road development proceeds, other supplies (notably the extensive deposits known to exist in the Sigatoka valley) will also become readily available. However a superficial inspection suggests that, with the C.S.R. Company looking after the liming of cane lands, the present sources of supply should also be able to provide for the annual demand by other farmers on Viti Levu, at least for some years to come. One reason for this lies in the fact that the demand for lime will only approach the actual need for lime when farmers, particularly peasant farmers, realize that lack of lime may be reducing their crop yields.

The following table lists the sources of supply that were sampled.

Locality	Type	Present Usage	Origin of sample.
1. Sigatoka Quarry near township	Limestone (soft to hard)	For road surfacing ..	Taken from quarry by Senior Chemist.
2. Tau	Limestone (very hard) ..	Burnt lime for Goldmines	Taken from quarry by Senior Chemist.
3. Malaqere	Limestone (hard).. ..	Burnt lime for C.S.R. Mills	Dump at Lautoka mill.
4. Dreketi Inlet near Lautoka	Shell limestone	For cane fields	Dump at Lautoka Mill.
5. Vuda Point	Coral sand and shell ..	For road surfacing ..	Taken from road dump by Senior Chemist
6. Natunuku Beach near Ba	Shell limestone and coral sand	None. Very small deposit	Taken from site by Senior Chemist.

Locality	Analysis	
	Neutralizing Value	Ratio (MgCo3/CaCo3)
1. Sigatoka	93·3	0·01
2. Tau	100·9	0·04
3. Malaqere	96·0	0·01
4. Dreketi	58·3	0·04
5. Vuda Point.. ..	96·6	0·09
6. Natunuku	89·0	0·02

All samples are of reasonably good quality except the Dreketi sample which is rather poor. The neutralizing value is always somewhat higher than the true calcium carbonate and magnesium carbonate combined, but it is a useful figure for evaluating a liming material.

All samples contain small amounts of magnesium—up to nearly a tenth of the total amount of carbonate.

The Sigatoka limestone seems to be the most promising supply for agricultural exploitation. It is of good grade, easily accessible and in some cases so loamy that a rock grader could probably turn out a fairly fine material. The Public Works Department might be willing to take the coarser grades for road surfacing leaving the finer ones for agricultural purposes.

—N.G.C.

RESPONSE TO LIME IN VITI LEVU

This report aims at presenting a summary of all previous experiments with liming materials. Most of the officers of the Department who were concerned with these experiments have been consulted and it is probable that all the information available has been reviewed, with the possible exception of odd trials of a purely observational nature.

The liming material used has been coral sand in all but one instance.

No.	Location and Soil	Crop	Experiment	Results
A6/48	Alluvial flats, Navua ..	Pasture ..	Factorial Experiment	Significant response; yield increase of 15 per cent for coral sand at 3 tons per acre.
	Colluvial Soil, Kasavu R. Valley	Rice ..	Randomized block ..	Significant response; yield increase of 20 per cent for coral sand at 3 tons per acre.
A16/49	Alluvial flats, P.A.S.. ..	Rice ..	Statistical	Slight increase due to coral sand was not significant.
A17/49	Alluvial flats, P.A.S. ..	Rice ..	Statistical	No significant response to coral sand or to any other treatment.
	Hill soil, Tailevu . ..	Pasture ..	Semi-statistical ..	Apparent response. Apparent yield increase of 23 per cent for lime at 1 ton per acre and 45 per cent for coral sand at 5 tons per acre.
	Alluvial flats, Rewa ..	Sugar Cane	No field experiment, but a statistical review of yields and the "lime requirement" of the soils (Courtesy of C.S.R. Co.)	Response to lime can be anticipated for soils which show by laboratory test a "lime requirement".
	Sangram Estate, Ra ..	Pasture ..	Observational only ..	Apparent marked response in yield and in legume content to coral sand at 3 tons per acre.
	Uciwai	Pasture ..	Observational only ..	Apparent marked response to coral sand at 3 tons per acre.
X1/49	Togobula and Lomawai .	Pasture ..	Observational only ..	,,
	Vatia Point	Pasture ..	Observational only ..	Apparent response to coral sand at 3 tons per acre.
	Korovuto	Pasture ..	Observational only ..	Apparent slight response to coral sand at 3 tons per acre.
	Sarava, Ba.	Pasture ..	Observational only ..	No apparent response to coral sandat 3 tons per acre.
	Tailevu (2 sites)	Pasture ..	Observational only ..	,,

Only the results of statistically valid experiments can be accepted with confidence. Therefore the word "apparent" has been used in stating the results of observational trials, even though the differences in yield which were reported in these trials may have appeared to be very great.

SUMMARY AND CONCLUSIONS.

1. Pasture on the Navua flats, and rice in the Kasavu River valley near Nadurulou-lou, both responded to coral sand dressings of 3 tons per acre.

2. Sugar cane on the Rewa River alluvials can be expected to respond to liming whenever the soil shows a "lime requirement" by laboratory test.

3. It would appear reasonable to expect response to coral sand in two out of three cases of "average" pasture: that is wherever there exists no specially unfavourable factor such as very poor drainage, excessive slope or dominant weed growth.

Soil tests can be made to assess the chances of success.

4. It is noticeable that ground limestone has only been tried in one instance ; in which case only one fifth of the application appeared to give half the benefit produced by coral sand. From the known value of finely ground limestone it would be worth further trial.

—L.W.H. and N.G.C.

VETERINARY . . .

THE CLEANSING, CARE AND HANDLING OF DAIRY UTENSILS AND EQUIPMENT

BY T. P. GARDINER

It is often wondered whether the dairy producer and distributor are fully aware of the danger to the health of the community and the financial loss they incur, when placing a faulty or inferior product on the market caused by neglect and carelessness.

Dairy production in this Colony falls into three categories, namely:—

(*a*) The production and sale of milk for human consumption ;

(*b*) The production and sale of cream to the butter factory for the manufacture of butter ;

(*c*) The production of cream for the manufacture and sale of ghee.

The Public Health Ordinance defines all three milk, butter and ghee, as alimentary products. Therefore too much emphasis cannot be placed on cleanliness and hygiene in the production and distribution of milk products, for a large percentage of the population are either ignorant of pasteurising (scalding) before use, or are against doing so with the result that milk containing disease-producing organisms could be, and has been, responsible for outbreaks of disease.

Milk is an excellent medium for the growth and multiplication of bacterial organisms.

Cleansing and Hygiene.—Contrary to common practice where milkers are often observed working in the cowshed wearing dirty clothing, an endeavour should be made to be of clean habit, for unless a person is such, it is unlikely he will be clean in his work.

For instance, his hands should be washed in clean water between the milking of each cow, and the milk bucket if showing signs of dirty sediment after the milk has been tipped, should be rinsed before milking is continued.

It is useless for a milker to wash his hands, and then take hold of a dirty milking stool or door handle which in some cases are rarely, if ever, washed after each milking. The "cheesy" formation of scum which forms on both of these through not being properly washed every day is a sure source of bacterial contamination.

It is recognised that the provision of a good clean water supply is essential for washing down cows' udders or any milking utensil, and not water from a dirty well or stagnant pool. A good catchment such as a tank or a concrete cistern is ideal. However, should the construction of a concrete cistern not be possible, then the limited amount of tank water should be conserved for washing the cows' udders and milking utensils, while the well or other water may be used for washing down the concrete, milking stools, door handles and internal structures of the cowshed.

After the milking has been completed, we come to the washing up of the milking utensils when the following method should be observed.

Firstly, everything should be washed in clean, cold water, followed by a thorough washing in water as hot as the hands can bear, to which has been added ordinary washing soda at the rate of $\frac{1}{4}$—$\frac{1}{2}$ teaspoonful per gallon of water. This should then be followed by a thorough rinsing in boiling water and everything spread out in a clean airy milk room. Under no circumstances should the utensils be dried with a cloth. It is most essential that every part of the separator be washed separately and a suitable set of brushes provided.

After scrubbing down the floor of the milk room, especially around the separator or where the milk is unavoidably spilt, it should if possible, be rinsed down with any remaining boiling water.

Cowshed and Surroundings.—On washing up after the milkings, the cowshed and milk room should be left open as much as possible so as to ensure good ventilation. This is useless if the owner allows dirty blocked drains and great heaps of cowyard manure to accumulate close to the cowshed. The atmosphere becomes laden with bacteria and is a sure source of contamination to the milking utensils and ultimately the milk.

The walls, door handles, milking stools and internal structures should be washed down, and if done daily, this is not nearly

such a big undertaking as is sometimes imagined.

Storage of Milk and Cream.—Little need be said here regarding the storage of milk. It is usually distributed as soon as it is drawn. However, the following points should be observed:—

(*a*) The milk cans and lids must be thoroughly clean, and if possible rinsed with boiling water, then followed by a clean cold water rinse just before milking in order to remove any particles of dust.

(*b*) As an alternative to cooling, which is difficult in this Colony, it is advantageous to place the cans in a container of cold water and keep the milk regularly stirred throughout the milking to facilitate aeration and assist the disposal of certain gas-forming bacteria and undesirable flavours.

(*c*) The milk strainer must be sterilized both before and after use. There are several types available and the one recommended is where a new filter paper can be used for every milking. The use of a piece of cloth, unless boiled after every milking, is to be discouraged.

In respect of cream production, it cannot be too strongly emphasised that with a little more care and attention a much better and higher graded product could be delivered to the factory or made into ghee.

The same precautions should be followed as for milk production.

The cream, when separated, should not be mixed with cold cream of the previous milking, but if mixing is unavoidable it should be thoroughly stirred and followed by regular stirrings until delivered to the factory or made into ghee.

The stirrer should be metal and of the plunger type, and not a piece of wood as is frequently seen.

Cream should always be covered with a wire gauze cover to protect it from fly attack. If covered with a lid, aeration is impeded. When being despatched to the factory cream is often left out in the sun with no protection. This should be guarded against and some form of light cover or protection from the effect of hot sun provided.

Transport and Handling.—During the course of inspections it has been observed that badly dented buckets and cans are used. These are a constant source of bacterial contamination through grease lodging in the crevices.

It is recognised that replacements are both difficult to obtain and expensive, but with careful handling cans will last much longer. This not only applies to the producer but a considerable saving could be made by the cream carriers if more care were exercised in the handling of the cream cans.

It must be recognised that the climate of tropical countries is not always favourable to the production of a first class dairy product, therefore no effort must be spared in maintaining a high standard of hygiene.

Dairy farmers should not hesitate to discuss their problems with the Departmental Officers, whose aim is to advise and assist when and wherever possible.

DISEASES OF POULTRY IN FIJI

BY K. J. GARNETT

This Colony is fortunate in that many of the severe poultry diseases which are found overseas are not present in Fiji. However although these serious diseases do not decimate our flocks there are many less acute conditions which seriously check growth and productivity. In this series of articles it is proposed to follow closely the classification given by Hungerford[1], but only those conditions seen in Fiji will be dealt with.

The first series of conditions to be dealt with is those diseases which are commonly classed in the pouitry industry as " Roup ".

A. ROUP DISEASES.

I. FOWL POX.

This is one of the most common diseases of poultry the world over. Fowl and turkeys are particularly susceptible but natural outbreaks in ducks, geese and other birds are uncommon.

The disease is chiefly seen in young birds but not usually before they are three weeks old. Birds over nine months which have almost certainly been exposed to infection earlier in their lives develop an immunity and are not usually affected. The disease is caused by a virus (a similar type of "germ" to that which causes the common cold and 'flu in human beings.) It has been observed that anything which will lower the general health and condition of the birds, such as heavy worm infestation, faulty feeding and overcrowding, will render them more susceptible to an attack of the disease.

The popular belief that the disease is spread by mosquitoes is largely correct and measures taken to control these insects are definitely beneficial. Birds are always fighting and the small wounds in the skin enable the virus to enter the body. Water in drinking containers soon becomes contaminated if there are one or two infected birds in the flock and other birds which may have small injuries to the lining of their mouths from eating sharp particles of grit soon become infected.

After the virus enters the body a period of from three to fourteen days may elapse before symptoms are noticed.

It should be noted, that just as there are various types of measles in human beings, so are there different strains of the fowl pox virus. After a bird has recovered from an attack of fowl pox it is immune for the rest of its life to a further attack by that particular strain of the virus, but it may be attacked by another strain. To date it has not been possible to type the strains of fowl pox present in the Colony.

(*a*) *The cutaneous form* in which tiny blisters develop at the site of introduction of the virus to the bird's body.. These blisters break down into " sores " which exude a yellowish material like pus which dries and darkens to form " wart " or " pox " lesions which are firmly adherent to the sore underneath. These pox lesions are mostly seen on the comb and wattles and about the eyes but are frequently seen also on the legs and toes and in severe cases all the unfeathered parts of the body may be affected. The bird becomes dull, wings are drooped and it may refuse to eat.

(*b*) *The canker or diphtheritic form* is usually preceded by the affected birds becoming dull and huddled up and having no appetite for food. There may be a cough. If the mouth is opened cheesy deposits will be found and if these are forcibly removed a raw bleeding surface remains.

(*c*) *Oculo-nasal form.*—The bird becomes dull and then a watery discharge is seen from the eyes and nose and the bird may sneeze frequently. This discharge becomes thicker and the eyelids stick together so that one or both eyes may become " bunged up ". This discharge finally becomes cheesy and both eyes may be very swollen, also the sides of the face. A cheesy crust may also develop in the mouth, particularly around the cleft in the roof of the mouth which frequently becomes blocked and forces the bird to breathe through its mouth.

Birds may show only one of the above forms but various combinations including all three together are frequently seen.

In a very severe outbreak in young chickens the mortality may be up to 50%, but generally speaking deaths are fairly light—around the 5% mark—and the main loss is the set-back which the birds receive as an outbreak may cause a check which puts the birds back for up to two months.

Once the disease has broken out in a flock there is very little in the way of treatment that is of any real value. It must be remembered that the crusts and cheesy deposits are only an outward symptom of the disease which is having its most harmful effects by setting up a generalised fever right through the body of the bird. Treatment of the eyes and affected areas with mercurochrome, iodine, washing blue and the like is of slight benefit as far as those areas are concerned, but it must be remembered that the virus which has spread right through the body is not being checked in any way. Prompt isolation of affected birds from the rest of the flock as soon as an outbreak is suspected is a sound practice but because the incubation period may be up to fourteen days this measure cannot be relied upon to arrest the condition. The addition of a teaspoonful of Lugol's Iodine (*Not* ordinary tincture of iodine) to each gallon of drinking water will also help to control the spread to a slight degree. *However, in spite of numerous claims by a variety of people, it is generally agreed that there are no really reliably tested remedies known to cure the disease* and the only reliable method of controlling the condition is by vaccination of chickens. To date little has been done in the way of vaccination of chickens in Fiji, but the practice is widespread overseas and has given very beneficial results. The ideal age for vaccination is between ten and twelve weeks, and farmers who are interested should contact officers of the Department of Agriculture. In no circumstances should home vaccination be attempted as there are many factors to be taken into consideration and inexperienced persons are likely to end up with disastrous results.